

on the success obtained in the building of the lofty mansion in which they were assembled, which is at a little distance from the place where the Society was founded in 1821.

In his just-published report to the Foreign Office on the trade and agriculture of French Guiana, Consul Wooldridge forwards some information of considerable interest in regard to the production of gold in that region. The quarter of Mana, hitherto unknown as a gold-producing territory, has, through the energetic endeavours of adventurers, been prospected, and is speedily being opened up; indeed, it promises to be one of the richest gold industrial quarters. The production of gold at a few hastily-established placers, in the month of March last year, gave 21,747 grammes of pure gold, and in April 39,662 grammes. It is to be feared, however, that the gold-workings here and in other parts where the precious metal is found to a large extent is having a disastrous effect on the general prosperity of the colony, for Her Majesty's Consul, quoting from the report of the Commission which periodically proceeds to the various quarters to inspect estates, draws a melancholy picture of the abandonment and poverty of agricultural property in French Guiana.

THE latest work of the leader of the Austrian North Polar Expedition, Captain Karl Weyprecht, entitled "Die Metamorphosen des Polareises," is now in course of publication at Vienna (Perles).

A CURIOUS statement appears in the foreign correspondence of the *Times*, that Russian papers state that the Amu-Darya has returned to its original bed. This may very well be the case without any or much interference on the part of man, as may be seen from Major Herbert Wood's articles on the Aral region in vols. xi. and xii. of *NATURE*. About twenty years ago the Loodon Canal at Bend, above the splitting up of the lower Amu, was dammed up. This canal seems to have been connected with the old course of the Amu into the Caspian, and a strong flood breaking down the dam might easily cause the river to resume its old course, especially as its present mouths seem to be gradually filling up with the abundant matter brought down by its waters. It is apparently at Bend that the deviation has taken place.

AN able review of Geography at the Paris Exhibition appears in the last number of the *Revue Scientifique*.

THE TELEPHONE, ITS HISTORY AND ITS RECENT IMPROVEMENTS¹

I.

THE appearance of the two works mentioned below is indicative not only of the remarkable era of scientific invention through which we are passing, but also of the wide-spread interest in science which these inventions have aroused.

It will be noticed that neither of these works is published in England: one reaches us from America, the other from France. As a nation we are slow to appreciate the value of new inventions—a conservatism which arises less from caution than from popular ignorance of science; nor will an enlightened public opinion be possible until the first principles of science form an integral part of the education of every English boy and girl. But now that science is walking in the market-place, and holds its own on the exchange, ignorance of its elements becomes commercially perilous. A sound judgment on the value of a new scientific discovery may at any moment be indispensable to capitalists and very profit-

able to shareholders. We venture to say that such a conviction has been a prevalent idea on almost every stock exchange during the recent panic in gas shares. Scientific knowledge has presented itself in a new light: it is now a commercial article; and forthwith the British public promptly recognises its value. In fine, the business aspect of recent inventions may do more for the future extension of science teaching than years of earnest expostulation.

The two works before us cover nearly the same ground. They give the history of the invention of the telephone, the methods that have been devised for electrically transmitting and receiving speech, with the most recent improvements down to a month or two ago; they also describe the phonograph; and Prescott's book, while omitting the microphone, which is fully discussed by Du Moncel, devotes its concluding chapters to quadruplex telegraphy, electric call-bells, and electric lighting.

Of the two works Count du Moncel's is the more scientific, comprehensive, and impartial, and will add to the high reputation which its indefatigable author already possesses as the historian *par excellence* of the applications of electricity. We can therefore most heartily commend this treatise to our readers; it is, moreover, well printed, capitally illustrated, and withal published at a very low price.

Mr. Prescott's work is larger, the typography and illustrations are excellent, and in technical details and recent information it leaves nothing to be desired. The arrangement, however, is confusing. The body of the work consists almost wholly of reprints from the various papers, lectures and specifications of the workers at electric-telephony, and the absence of marks of quotation with the want of proper indication where one extract ends and another begins not only puzzles the reader but is apt to give rise to serious misapprehension. The work has obviously been hastily prepared for the press, repetitions are frequent, and the matter is arranged with little regard to the reader's convenience or to chronological sequence. Moreover, its author has an evident bias towards American inventions in general and the "Western Union Telegraph Company" in particular. It is true the work professes to deal with speaking telephones only, but as some American "tone telephones" are described in detail, we are surprised at the entire omission of the early and important telephonic experiments by Cromwell Varley in London, and afterwards by La Cour in Copenhagen.

Nevertheless, with all its defects, Mr. Prescott's book is a useful and needed contribution to scientific literature, and as each inventor is allowed to speak for himself, the careful reader is enabled to form his own judgment on certain disputed questions of priority of invention.

It is time that the history of the articulating telephone was written. Hitherto the English public have had little more to guide them on this subject than the lectures given in London by Prof. Graham Bell, lectures delivered with altogether admirable grace and diction. It is very natural that an inventor should give more prominence to his own ideas than to those of others, and hence the impression generally derived from Prof. Bell's lectures is that the sole credit of the first conception and successful construction of the articulating electric telephone is due to himself. There were, however, other workers in the field of electric-telephony besides Mr. Graham Bell, and it is to be regretted that Prof. Bell did not give sufficient prominence to this fact in his discourses. Mr. Prescott, indeed, brings some serious charges against Prof. Bell, asserting that to another American, Elisha Gray, of Chicago, is due the entire priority and merit Bell claimed for himself. Here is what Mr. Prescott says:—

"It was not till after Prof. Bell had substituted the apparatus shown in Mr. Gray's *caveat* that he was enabled

¹ "The Speaking Telephone, Talking Phonograph, and other Novelties," by G. B. Prescott. Illustrated. (New York: Appletons, 1878.)—"Le Téléphone, le Microphone, et le Phonographe," par Le Comte Th. du Moncel. (Hachette, 1878.)

to successfully accomplish the grand object of reproducing articulate speech at a distance" (p. 73).

A little further on Mr. Prescott remarks:—

"From the reading of the text [Prof. Bell's lecture in London] it might be erroneously inferred that the apparatus shown [a water variable-resistance telephone] was invented by Prof. Bell, and exhibited by him at the Centennial Exhibition. Prof. Bell neither invented nor exhibited it. The figure [given by Bell] represents the transmitting portion of Elisha Gray's original speaking telephone, the first articulating telephone ever invented. Mr. Gray experimented with the telephone at the Centennial Exhibition in America in 1876, and showed it, among others, to Prof. Barker, but did not exhibit it to the judges."

Even with reference to the present shape of Bell's telephone, Mr. Prescott denies that Bell was its inventor and he adduces evidence to show that the present portable form of the handle telephone was due to Dr. Channing and Mr. Jones, of Providence, R.I. This, however, is a minor matter, but the question of priority of invention of the principle of the articulating telephone is one of general interest and importance.

To the consideration of this matter the Count du Moncel brings not only an independent and unbiased mind, but also a profound technical and historical knowledge of the various applications of electricity. And in the following opinion, which he expresses, we entirely agree:—

"Si M. Bell a été le premier à construire et à rendre pratique le téléphone parlant, M. Elisha Gray avait le premier conçu le principe de cet instrument et l'avait combiné en electricien consommé."

A similar opinion is expressed in a very able and lucid discourse by a well-known electrician, Mr. F. L. Pope, delivered last December before the American Electrical Society at Chicago, reprinted in Prescott's book. At the same time we must bear in mind Prof. Graham Bell had for some time back also been at work at a similar problem to that which had led Gray to the conception of an articulating telephone, namely, the problem of multiple telegraphic transmission by means of harmonic vibrations, and from this subject was led to the discovery of his magneto-electric telephone. As Mr. Pope remarks, "when we consider that each was working in ignorance of the labours of the other, the singular coincidence in the results they finally obtained is not a little remarkable." To Gray and Bell a third name has also to be added, namely, that of Edison, to whose work we shall refer more fully in another article. These three names stand conspicuously forth in connection with the discovery of the speaking telephone, and we therefore propose to trace the relationship each bears to this subject.

The dominant idea that stimulated each of these inventors was the possibility of transmitting several messages simultaneously along one wire. By his patent of 1870 Varley had led the way to the method by which this could be accomplished; he succeeded, in fact, in transmitting secondary currents, generated by the vibration of a tuning fork, in the primary circuit of an induction-coil, concurrently with the ordinary Morse signals, the former not sensibly affecting the usual electro-magnetic receiving apparatus, but producing audible signals on a peculiar receiver of his own. After this, in September, 1874, La Cour, of Copenhagen, patented an apparatus for multiple transmission, founded on a modification of Varley's plan. In this case the receiver was a tuning-fork, controlled by an electro-magnet, and tuned in unison with the transmitting fork, hence it was capable of being thrown into sympathetic vibration by the electric waves started by the latter. A series of such duplicate forks was employed corresponding to the notes of the musical scale, and it was found that the intermittent currents of several of these forks could be simultaneously transmitted without confusion, each re-

ceiver selecting and vibrating under its appropriate system of electro-magnetic impulses. Early in 1875 Gray, of Chicago, patented a somewhat similar, but more perfect arrangement. Gray's caveat, or application for his patent, dates from August, 1874, so that in point of fact he anticipated La Cour's method. Instead of using tuning-forks Gray employed strips of steel as being lighter and more sensitive; each transmitting reed instrument had, of course, its fellow at the receiving end, which promptly responded to its own system of waves, acting upon it through an adjacent electro-magnet.

The idea of synchronising the movements of two instruments at wide intervals apart by employing the principles of isochronous vibration is not novel, it was carried out by Helmholtz in his experiments on vowel sounds; and still earlier distant isochronous pendulums were used in telegraphy to control machinery, by Vail, in 1837, Ronalds in 1861, and Hughes in his printing-telegraph. But Gray accomplished more than this. Reiss, in 1862, had shown by his telephone how the rate of vibration might be electrically transmitted and reproduced, but the amplitude and mode of vibration were lost; Gray, towards the close of 1874, discovered a method whereby the proper amplitude of each vibration or combination of vibrations could be reproduced, "by causing the effective strength of the electric current, by which the transmission is

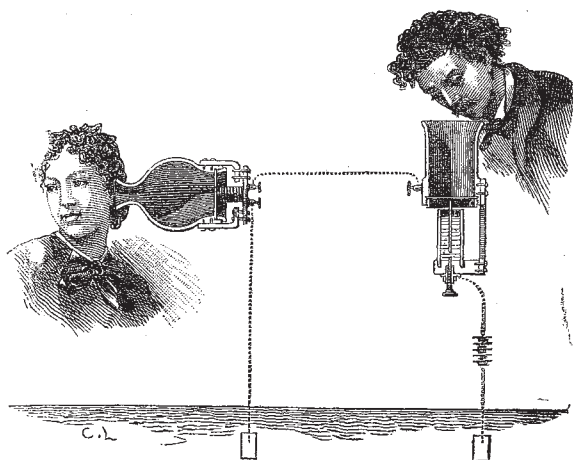


FIG. 1.—Original arrangement for the electric transmission of speech designed by Gray. A current from the battery on the right passes into a vessel containing water, into which dips a wire attached to the vibrating membrane and in circuit with the line. (From Du Moncel's work.)

effected, to rise and fall with the varying amplitude of the sonorous waves which are to be reproduced." Hence, as Mr. Pope, in the discourse to which we have alluded, goes on to remark:—"This having been accomplished, it was not difficult to foresee that two practical applications might be expected to follow, namely, multiple transmission and vocal transmission."

There yet remained however the difficulty of impressing upon an electric current the rapidly-changing forms of the sonorous waves which occur during the act of speaking. In the beginning of 1876 Gray conceived the idea of accomplishing this by attaching to a stretched membrane, such as was used by Reiss, an arrangement whereby the movements of the membrane should produce proportional alterations in the resistance of an otherwise constant electric circuit. Undulatory currents of fluctuating strength would thus be set up by the voice, and these, acting electro-magnetically upon a diaphragm at the far end—to which was attached a piece of soft iron—would cause it to be thrown into vibrations corresponding to those existing at the transmitting end. The problem of the transmission of speech was thus

theoretically solved. On February 14, 1876, Gray registered this invention at the American Patent Office, under the title of "a means of transmitting and receiving vocal sounds telegraphically," and in his caveat he gives an exact drawing of the method he adopts, and which we here reproduce.

Curiously enough, on the very same day, there appears the first documentary evidence on behalf of Prof. Graham Bell, and this, too, is for a patent granted to Bell—not, however, for the electric transmission of speech, but "for certain new and useful improvements in telegraphy." These improvements consist in the employment of *induced* undulatory electric currents, and form one of the numerous practical applications of Faraday's famous discovery of magneto-electric induction. By the approach and recession of the prongs of a magnetised tuning-fork, or by the oscillation of a magnetic diaphragm, alternating currents were generated in an adjacent coil of wire. This is the essence of Bell's patent, the advantages claimed by the use of such undulatory currents being increased speed of telegraphy and the possibility of multiplex telegraphy. Nothing is said about the transmission of speech till near the end of the specification, when it is stated that "one of the ways in which the armature may be set in motion [to generate these currents] is the wind. Another mode is the human voice, or by means of a musical instrument." So that, of the five claims made by this patent, the last, and apparently quite subsidiary one, was "the method of transmitting vocal or other sounds telegraphically." A diagram of the arrangement devised for this purpose accompanies the specification, which arrangement, however, upon subsequent trial, proved, as Prof. Bell stated in London, "unsatisfactory and discouraging." It is not, however, fair to conclude, as Mr. Prescott has done in the words we quoted earlier, that Bell had to resort to Gray's method before he was enabled to transmit speech electrically. The fact seems to be that some little time after he obtained his patent, Bell turned his attention to the development of the speaking telephone, and by a modification of the method he originally proposed, arrived at some important results which were published on May 10, 1876, in the *Proceedings of the American Academy of Arts and Sciences*. Sir W. Thomson heard articulate sounds transmitted by this telephone in August, 1876, but the instrument was then very imperfect, nor was it until the early part of 1877 that the speaking telephone may be said to have been a *fait accompli*; in May, 1877, it was successfully tried between Providence and Boston, places forty-three miles apart. There seems reason to believe that the important improvement of the substitution of permanent magnets for electro-magnets was made at the suggestion of Prof. Dolbear, and that Professors Peirce, Blake, Channing, and others contributed valuable modifications of the original design, until the Bell telephone assumed its present simple, elegant, and handy shape, growing in efficiency as it diminished in size and complexity.

Thus it will be seen both Gray and Bell can fairly claim the discovery of the principle of the articulating electric telephone. Gray solved the problem first theoretically, Bell first practically; the former proposed to vary the resistance of the circuit without changing the electromotive force; the latter varied the electromotive force without changing the resistance. And although Gray's method was only partially successful in operation, owing to his employing an electrolytic resistance, it is a method capable of yielding more striking results, owing to the use of more powerful currents. But where Gray failed, Edison has succeeded, and in another article we propose to trace the connection of this remarkable inventor with the subject of electric-telephony, up to his splendid discovery of the carbon telephone.

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COLOUR BLINDNESS IN RELATION TO THE HOMERIC EXPRESSIONS FOR COLOUR¹

II.

SO far as I can follow Mr. Gladstone's investigations, it appears to me that Homer has exactly fulfilled all the conditions mentioned in the previous article. As many references are made to natural objects which have the same colours now as they had in his time, I am able, with my colour-blind experience, to judge what sensations they would present to his eyes, supposing him colour-blind, and I can thus form a judgment of the appropriateness and consistency of his descriptions on that hypothesis. I can clearly trace the existence of two groups of epithets, which, so far as I can see, are kept fairly distinct, and the words in which are never mixed up with the ideas belonging to the contrary group. The epithets are—

For the group of the yellow sensation: *ξανθός, ἐρυθρός, φοῖνιξ, ῥοδόεις, χλωρός, κυάνεος*, and perhaps *οἶνοψ*.

For the group of the blue sensation: *πορφύρεος* and *ιοειδής*.

For neutral sensations, irrespective of the words *λευκός* and *μέλας* (which may be left out of consideration altogether, the use of them being normal, and the vision of the colour-blind in regard to them being normal also) there is the epithet *πολύς*, on which an important element of the argument hangs.

We will now take these various words *seriatim*, and compare what Mr. Gladstone says of their application with the use that might be expected to be made of them by a colour-blind writer.

Ξανθός.

Liddell and Scott's translation of this word is "yellow of various shades, often with a tinge of red, chestnut, auburn." Mr. Gladstone (N. 380) considers it, as used by Homer, to be a true word of colour, and that its applications are especially consistent.

It is used principally for human hair, and to the colour-blind *all* varieties of hair, except such as is positively jet-black, appear shades of yellow. Fair or golden hair is a light yellow, red and auburn hair are deeper tones, more intensely coloured, and all varieties of brown are darker still.

The word is also used for the colour of horses. All the varieties of chestnut and bay are to the colour-blind dark yellow, a yellow brown, the former of a lighter, the latter of a darker shade.

Ἐρυθρός.

This is, I suppose, the most usual Greek word for red.

Mr. Gladstone (N. 375) takes it to be the best approach to a true genuine colour-epithet, but at the same time he remarks how strange it is that Homer's idea even of red does not seem to be wholly distinct.

The difficulty, however, vanishes if we suppose Homer to have been in the position of the colour-blind, to whom, as I have explained, the proper idea of red is unknown. The word, according to Mr. Gladstone (N. 375, H. 460), is applied to copper, nectar, wine, and blood, all which, though they may differ in appearance to the normal-eyed, present to the colour-blind only different modifications of the yellow sensation.

In regard to blood, the hue varies according to its condition, arterial blood differing materially from venous blood in its colour. I believe that normal-eyed people hesitate to recognise any yellow element in it in any condition, but it is quite certain that when bright and freshly-oxygenated, it presents a sensation of yellow to me; and this is consistent with the fact that its colour is said to be chiefly due to the oxygenation of the iron it contains, the peroxide of iron being to me very positively yellow.

I conceive it may be possible that in this, as in many

¹ Continued from p. 679.